St. Petersburg University
Graduate School of Management

Master in Corporate Finance

RESIDUAL EARNINGS AND BOOK VALUE IN EQUITY VALUATION ON CHINA STOCK MARKET

Master's Thesis by the 2nd year student
Concentration — MCF
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THE MASTER THESIS

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ЗАЯВЛЕНИЕ О САМОСТОЯТЕЛЬНОМ ХАРАКТЕРЕ ВЫПОЛНЕНИЯ
ВЫПУСКНОЙ КВАЛИФИКАЦИОННОЙ РАБОТЫ

Я, Лай Юн, студент второго курса магистратуры направления «Менеджмент», заявляю, что в моей магистерской диссертации на тему «Роль остаточной прибыли и балансовой ценности при оценивании компаний на рынке Китая», представленной в службу обеспечения программ магистратуры для последующей передачи в государственную аттестационную комиссию для публичной защиты, не содержится элементов плагиата.

Все прямые заимствования из печатных и электронных источников, а также из защищенных ранее выпускных квалификационных работ, кандидатских и докторских диссертаций имеют соответствующие ссылки.

Мне известно содержание п. 9.7.1 Правил обучения по основным образовательным программам высшего и среднего профессионального образования в СПбГУ о том, что «ВКР выполняется индивидуально каждым студентом под руководством назначенного ему научного руководителя», и п. 51 Устава федерального государственного бюджетного образовательного учреждения высшего образования «Санкт-Петербургский государственный университет» о том, что «студент подлежит отчислению из Санкт-Петербургского университета за представление курсовой или выпускной квалификационной работы, выполненной другим лицом (лицами)».

____ (Подпись студента)

____ (Дата)

ABSTRACT

Master Student's Name	Lai Yun
Master Thesis Title	Residual Earnings and Book Value in Equity Valuation on China Stock Market
Faculty	Graduate School of Management
Main field of study	38.04.02 “Management” (specialization: Master of Corporate Finance)
Year	2017
Academic Advisor's Name	Alexander V. Bukhvalov
Description of the goal, tasks and main results	This paper is an empirical test of fundamental valuation model that uses residual earnings and book value of equity on China stock market, including mainland China stock market and Hong Kong stock market. Fundamental valuation models are estimated for both markets on market level and industry level. Furthermore, utilizing the fundamental valuation model, this paper explains the market price discrepancy of dual listed companies on China mainland market and Hong Kong market. In conclusion, residual earnings and book value of equity is significant in the fundamental valuation model used and applied to China stock market data. Fundamental value difference can explain the market price difference of dual listed Chinese company.
Keywords	fundamental value, Ohlson model, China stock market, A-share, H-share

АННОТАЦИЯ[1]

Автор	Лай Юн
Название магистерской диссертации	Роль остаточной прибыли и балансовой ценности при оценивании компаний на рынке Китая
Факультет	Высшая Школа Менеджмента
Направление подготовки	38.04.02 “Менеджмент” (Профиль:Корпоративные финансы)
Год	2017
Научный руководитель	профессор А.В. Бухвалов
Описание цели, задач и основных результатов	Исследование основано на эмпирическом тестировании фундаментальной модели оценки, использующей нераспределенную прибыль и балансовую стоимость капитала в качестве независимых переменных на рынке капитала Китая, включая рынок капитала континентального Китая и рынок капитала Гонконга. Фундаментальные модели оценены для обоих рынков на рыночном и промышленном уровнях. Более того, используя фундаментальную модель оценки, исследование объясняет расхождение между рыночной стоимости для компаний, торгующихся на обоих рынках - рынок континентального Китая и Гонконга. В результате, нераспределенная прибыль и балансовая стоимость капитала значимы в используемой фундаментальной модели оценки и применимы для данных рынка капитала Китая. Разница в фундаментальной ценности способна объяснить различие в рыночной стоимости китайский компаний, торгующихся на обоих рынках.
Ключевые слова	Внутренняя стоимость, Модель Олсона, Китайский фондовый рынок, А-акции, Н-акции

[1] The Russian version of Abstract is only for reference. In case of any conflicts between Russian and English version, the English version shall prevail.

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Introduction

This paper is thesis of a master student of Corporate Finance. Valuation is an important and main component of Corporate Finance. DCF and multiple analyses of comparable company and comparable transaction are main valuation techniques widely used in the industry. This paper empirically tests a more advanced but also easy to implement valuation technique based on Ohlson (1995) Model.

China stock market is already the second largest equity market after US in terms of market capitalization. It comprises China mainland stock market and Hong Kong stock market. These two markets are segmented. A number of Chinese companies that are dual listed on the two markets have huge market price discrepancy. This paper creatively explains this market price discrepancy with fundamental valuation discrepancy between the two markets. The fundamental valuation model tested and estimated with China stock market data can easily calculate fundamental value of a large number of companies. In addition, as a valuation technique, it can be widely used together with DCF and comparables in China stock market context.

The two main research questions of this paper are:

- Is this fundamental valuation model applicable to China stock market?
- Does fundamental value explain price discrepancy for dual listed China companies?

This fundamental valuation model is a regression model proposed by Bukhvalov and Volkov (2005) and has not been tested on China stock market. Book value of equity and discounted residual earnings are independent variables of this model. This paper first confirms the significance of the two variables in regression with Chinese data. Then fundamental value of dual listed China company is derived from the model and used as independent variable against market value in a regression to check whether fundamental value can explain market price discrepancy.

The first chapter is an introduction part. It describes the background of China stock market and the phenomenon of dual listed company market price discrepancy. The second chapter is a theoretical part. It justifies the model and discount rate used in the research. The third chapter is empirical analysis, which explains how the data is collected and demonstrates and discusses the empirical results. The forth chapter analyzes price discrepancy of dual listed companies with fundamental value and other factors.

Chapter 1: China Stock Market Overview

1.1 China Stock Market

China mainland stock market is already the second largest equity market after US equity market in terms of market capitalization. It comprises Shanghai Stock Exchange and Shenzhen Stock Exchange. Shanghai Stock Exchange was established on November 26, 1990 and Shenzhen Stock Exchange was established on July 3, 1991. After over 20 years development, Shanghai Stock Exchange is now the world's fifth largest stock exchange and Shenzhen Stock Exchange is eighth largest stock exchange in the world by market capitalization.

From its birth, mainland China stock market is a segmented equity market from the rest of the world and Hong Kong. Foreign exchange and capital account are under control in mainland China. Chinese company and individual cannot obtain the foreign exchange or transfer money out of mainland China without justification of usage. Investing in capital market and real estate is not within the list of approval. This also holds for international investors. International investors cannot transfer the fund into China, purchase Chinese Yuan and invest in capital market in a legitimate way. Capital outflow and inflow are both restricted in mainland China.

As an emerging market, China mainland stock market is not an international or mature equity market regardless of its huge market capitalization. Till now, only Chinese company is allowed to list on the two stock exchanges mentioned above. Legal foreign capital, Qualified Domestic Institutional Investor (QDII), whose total quota is about 100 billion USD till 2016 (Ren, 2016), only accounts for a tiny portion of total market capitalization. Although the number of institutional investors in China is gradually rising, still around 44% of total market capitalization is held by individual investors. This number is much higher than mature equity market.

Hong Kong as a special administrative region is very different from China mainland politically and economically. Yet, Hong Kong is still part of China. By stating China Stock Market in thesis title, this paper implies China mainland stock market and Hong Kong market.

In Hong Kong market, stock is traded on Hong Kong Stock Exchange measured by HK Dollar (HKD). Hong Kong does not have foreign exchange control, various foreign currencies can be exchanged and remit without limit. Hong Kong has its own currency and implements the linked exchange rate system fixing one US dollar convertible to 7.80 Hong Kong Dollar.

Hong Kong Stock Exchange, whose establishment can be traced back to 1891, is now the sixth largest stock exchange in the world before Euronext in terms of market capitalization. The majority of listing on Hong Kong Stock Exchange is from Hong Kong and mainland China. Around 5% companies are from the rest of the world including two Russian companies (HKEX, 2016). According to HKEX News Release (2016), Hong Kong local retailing and institutional investor together contribute to less than 40% of the whole trading volume. The rest of trading volume is from various origins, mainly US, UK, and mainland China.

China opened its capital market after joining WTO in 2001 to a certain extent. In December 2002, China launched the Qualified Foreign Institutional Investor (QFII) program to permit licensed foreign institutional investors to trade on Shanghai Stock Exchange and Shenzhen Stock Exchange. The interdependence between China mainland and global stock market is raised by QFII (Li, 2012). In May 2006, China launched the Qualified Domestic Institutional Investor (QDII) program, which licenses domestic institutional investors to invest overseas. The introduction of the QDII program provided Chinese individual investors with opportunities to invest in international capital markets and Hong Kong capital market indirectly via purchasing QDII fund, share in private equity and insurance products. He et al (2014) utilizes the multi-factor R-squared measure to gauge the degree of stock market interdependence and tells that interdependence increased between China mainland stock market and the world after 2001.

Table 1.1, Correlation between Different Markets (July 1996-June 2008)

Markets	SHCI	SZCI	HSI	S&P 500
SHCI	1	0.912	0.147	0.0609
SZCI		1	0.127	0.0491
HSI			1	0.389
S&P 500				1

Table 1.2, Correlation between Different Markets (July 2002-June 2008)

Markets	SHCI	SZCI	HSI	S&P 500
SHCI	1	0.93	0.297	0.103
SZCI		1	0.252	0.077
HSI			1	0.408
S&P 500				1

SHCI, SZCI, HSI, and S&P 500 refer to Shanghai Composite Index, Shenzhen Component Index, Hang Seng Index, and S&P 500 Index respectively. Data source: Zhu and Jie, 2008

Table 1 and table 2, show the correlation between different markets. First, Shanghai Composite Index and Shenzhen Component Index are highly correlated. Second, Hang Seng Index is more correlated with S&P500 compared to SHCI and SZCI. Third, correlation between China mainland market and Hong Kong market increased significantly. Finally, correlation increased over time between all the markets listed above. In terms of correlation, China mainland stock market is segmented from the world, here represented by S&P500.

Shanghai-Hong Kong Stock Connect and Shenzhen-Hong Kong Stock Connect are the most recent trading mechanisms introduced to channel China mainland stock market and international stock market. Shanghai-Hong Kong Stock Connect was launched on 17 November 2014 and Shenzhen-Hong Kong Stock Connect is launched on 5 December 2016. Under these two programs, Chinese investors can trade most companies, especially blue chips, listed on Hong Kong Stock Exchange without establishing account in Hong Kong Stock Exchange. For international investors who opened account with Hong Kong Stock Exchange, they can trade many companies listed on Shanghai Stock Exchange and Shenzhen Stock Exchange without opening accounts in these two stock exchanges. Currency conversion is executed by exchanges thus investors do not purchase foreign currency and transfer it by themselves.

1.2 Dual Listed Share Phenomenon

When a Chinese company goes IPO in Hong Kong, its share trading on Hong Kong Stock Exchange is called H-share. On the contrary, for a Chinese company IPO and trades on Shanghai Stock Exchange and Shenzhen Stock Exchange, its share is called A-share. Till now, all companies traded on mainland China stock market are Chinese companies. Around one hundred Chinese companies, including financial institutions, are listed both in mainland China and Hong Kong. For these companies, they have both A-share and H-share.

A-share and H-share represents equal right. One A-share and one H-share of a company are same ownership. They have same voting power and receive same dividend. These companies use China Accounting Standards for Business Enterprises for both Hong Kong market and mainland China market disclosure. This means these companies report same net income in same currency, RMB, under same accounting standards to both markets. The only difference lies in circulation. H-share can only be traded in Hong Kong and A-share can only be traded in mainland China. One cannot buy share in one market and sell in another market.

All dual listed companies are either in the list of Shanghai-Hong Kong Stock Connect or Shenzhen-Hong Kong Stock Connect. One investor is free to choose and be able to invest in A-share or H-share either directly or through the stock connect. Yet we still observe significant price difference between A-share and H-share of a dual listed company.

Appendix 1 Dual Listed Company A/H Premium, attached in the end of the paper shows all companies that are dual listed in mainland China and in Hong Kong. Financial institutions are not included because they are not research objects in this paper. The second column, A/H premium, which is defined below, measures the price difference in percentage. HKDCNY, exchange rate, is the amount of Chinese Yuan needed to purchase one Hong Kong Dollar. HKDCNY is 0.89 on 21 April, 2017. This rate is used in premium calculation below in the table.

$$ {}^{A}\!/_{H}\ \text{premium} = \frac{\text{A share price} - \text{H share price} * \text{HKDCNY}}{\text{A} - \text{share price}} $$

According to law of one pricing, A-share and H-share should have same market value since they stand for present value of exact same dividend stream. Law of one pricing does not hold empirically for dual listed Chinese company. If H-share and A-share have the same market value, A/H premium should be zero. However, as observed in the table, the majority have a positive A/H premium. Three companies have higher H-share value than A-share value. For most companies, H-share is a lot cheaper than their A-share. Overall, the value of A/H premium varies greatly from company to company.

Limit of arbitrage is the direct explanation leading to such price difference. For one reason, A-share only circulates on mainland China stock market and H-share only circulates on Hong Kong market. One cannot buy where the share is cheaper, transfer the share to where the share is expensive, and sell the share. For another reason, investor can hold short position on one market and long position on the other market. But there is no guarantee that profit can be realized in certain period and having a short position is expensive. Price may converge or diverge.

Academia names this kind of stock as Siamese Twins (e.g. Scruggs, 2007; Froot and Dabora, 1999). Siamese Twins refer to stocks of a same company but are traded at different prices on different markets. The most famous Siamese Twins are Royal Dutch/Shell and Unilever NV/PLC. Froot and Dabora (1999) investigate these two cases and suggest three possible sources causing the price difference: tax-induced investor heterogeneity, noise shocks from irrational traders, and institutional inefficiencies. Institutional inefficiencies mainly imply index effect. For example, Royal Dutch was a member of the S&P 500 index. ETFs tracking S&P 500 were forced to buy Royal Dutch rather than Shell. Siamese Twins appear from time to time even in developed market.

Yet, a large number of Siamese Twins with such huge price difference, as the case of A-share and H-share, rarely occur.

For explaining the stock price difference for dual listed company on China mainland stock market and Hong Kong market, researchers already identified some factors. Wu and Gao (2015) used these dual listed companies as sample and found out that asymmetric information, liquidity, different demand elasticity can explain the difference of price. Cross boarder trading mechanisms are also found significant in explaining the price difference. Wang and Lin (2010) introduced dummy variable for the introduction of QDII and confirmed its significance. Qu et al (2010) created variables of investment amount of QDII and QFII and confirmed significance of both variables.

However, there is no paper test the price difference in the perspective of fundamental value difference. Here is where the research gap lies. One research question of this paper is that whether fundamental value discrepancy is a factor causing market value discrepancy between A-share and H-share. To achieve this, a fundamental valuation technique that can be quickly implemented to a great number of companies is required. DCF and comparables are not effective in this situation. We need a new fundamental valuation technique.

Chapter 2: Theory

2.1 Fundamental Value and Models

Fundamental value, which is also called intrinsic value, is the value of a company derived base on fundamental analysis. Fundamental valuation aims at deriving fundamental value that is as close as market value using accounting figures as input. Fundamental valuation is mentioned frequently in equity valuation. Dividend Discount Model (DDM) and Discounted Cash Flow (DCF) are the main methods taught in valuation class in business schools. Disadvantage of DDM and DCF is they need dividend and cash flow forecast. Using multiple comparables method, one needs to find comparables manually.

The Ohlson (1995) Model provides a neat and easy to implement fundamental valuation technique. The dependent variable is share price as shown in the model specification below. This valuation function does not require explicit forecasts of future dividends, nor does it require additional assumptions about the computation of terminal value. As Bernard (1995) comments, "The Ohlson (1995) and Feltham and Ohlson (1995) studies stand among the most important developments in capital markets research in the last several years. The studies provide a foundation for redefining the appropriate objective of valuation research."

Ohlson (1995) Model:

$$P_t = y_t + \alpha_1 x_t^a + \alpha_2 v_t$$

Where

$$\alpha_1 = \frac{\omega}{R_f - \omega}$$

$$\alpha_2 = \frac{R_f}{(R_f - \omega)(R_f - \gamma)}$$

y_t is book value at the end of period t.

x_t^a is abnormal earnings, residual earnings, for period from t-1 to t.

v_t is information about future abnormal earnings that is not in current abnormal earnings.

R_f is risk free rate plus 1.

ω is a autoregressive coefficient of abnormal earning. This will be introduced later.

γ is a a autoregressive coefficient of v_t. This will be introduced later.

The coefficients ω and γ are from linear information dynamics proposed by Ohlson (1995). The Ohlson (1995) assumes time-series behavior of abnormal earnings showed below. This relation is referred as linear information model (LIM) or linear information dynamics in later literature.

LIM:

$$x_{t+1}^a = \omega x_t^a + v_t + \varepsilon_{1\ t+1}$$

$$v_{t+1} = \gamma v_t + \varepsilon_{2\ t+1}$$

$\varepsilon_{1,t}$ and $\varepsilon_{2\ t}$ are the unpredictable, mean zero disturbance term, and ω and γ are persistent parameters that are non-negative and less than one (Ohlson, 1995). This LIM proposed by Ohlson (1995) suggests that x_t^a and y_t all follows AR (1) process.

We interpret this information dynamics the same way we interpret autoregressive process. The next period's abnormal earning, x_{t+1}^a, is from two components: x_t^a is current abnormal earning and $v_t + \varepsilon_{1,t+1}$ is shock that goes to next year's abnormal earning. The subtle difference between v_t and $\varepsilon_{1,t+1}$ can be seen from its time subscript t and t+1. v_t means that the shock is already known in the current period and has not passed into abnormal earning or net income yet. $\varepsilon_{1,t+1}$ means the shock is generated in the next period and cannot be predicted in the current period. ω is the speed that current abnormal earning decaying and also the speed that shocks decaying since current abnormal earning is partially from last shock. v_t as the information about future abnormal earnings not in current abnormal earnings follow a pure autoregressive process. There is no known element in the shock. For the reason above, ω and γ should be less than one thus shocks die away in the time series.

In addition to linear information dynamics, clean surplus accounting relation is another assumption required to derive Ohlson (1995) Model. This relation is denoted as CSR in literature. With CSR and LIM, dividend discount formula can be easily transformed to Ohlson (1995) Model.

CSR:

$$y_t = y_{t-1} - d_t + x_t$$

y_t is the book value of equity at time t.

x_t is net income for the period from t-1 to t.

d_t is dividend paid for the period from t-1 to t.

Clean surplus relation implies that changing in book value of equity is from earrings and paying out dividend. Yet CSR is violated in reality. Unrealized Gains and Losses on Securities Held for Sale and Foreign Currency Translation Gains and Losses are usually referred as dirty surplus that are included in retained earnings but do not pass net income. However, in many empirical studies of Ohlson Model, such as Ota, Koji (2002) and Dechow et al (1999), this problem is ignored. Hand and Landsman (2004) suggest that violating clean surplus relation is not a serious problem. Nowadays, more and more companies start to report comprehensive income. In China, Accounting Standard for Business Enterprises No.30 released in 2014 obligates companies to report comprehensive income. In this paper, CSR problem is also ignored. There is opportunity in future research is replace comprehensive income with net income when sufficient data is available.

Dechow, Patricia M., Amy P. Hutton, and Richard G. Sloan (1999) empirically tested the Ohlson (1995) model on US data from 1976 to 1995. Many other regression models, for example a simple regression of share price on book value of equity and earnings, are compared with Ohlson (1995) model. The paper also tested regression of share price on expected dividends for periods ahead. In conclusion the paper pointed out that Ohlson (1995) model is generally similar to past applications of traditional earnings capitalization models. Nevertheless, this paper confirmed the significance of linear information dynamics proposed by Ohlson (1995). This linear information dynamics is also verified by Ota, Koji (2002) on Japanese data.

The main contribution of Ohlson (1995) is not the model itself but the thinking to link fundamental value directly to present accounting data rather than expected future dividend or cash flow. Also the linear format of the model equation and the development of econometrics encouraged researchers to utilize econometrical method to carry out fundamental analysis. For example, Barth, Mary E., et al (2005) used pooled panel with and without Ohlson (1995) LIM restriction empirically compared these two situations on US data.

Ragab and Omran (2006) used book value and residual income as independent variable and pooled panel data analysis on Egyptian market from 1998 to 2002. Cheung et al (1997) used book value per share and earnings per share derive fundamental value of company and developed profitable trading strategies on Hong Kong market. The two regression models inspired by the

Ohlson (1995) paper do not emphasize the linear information dynamics and the coefficients are directly from regression result.

We also see many scholars modify Ohlson (1995) linear information dynamics to propose new model in valuation for example Ang, Andrew, and Jun Liu (2001) and Zhang (2000). All these paper refers back to Ohlson (1995) paper as the pioneer in this field.

After Ohlson (1995) paper, Ohlson himself is also developing his model. Feltham and Ohlson (1995) improved the original linear information dynamics by differing operation asset and financial asset in a company. Gode, Dan, and James Ohlson (2004) incorporate risk into the ohlson model.

There are many empirical studies of ohlson model on China mainland stock market. Most of them are Chinese students' master and doctor thesis and are written in Chinese. Li Xing (2010) tested Feltham-Ohlson Model on Chinese market with data from 2001 to 2008. His result supports the applicability of Feltham-Ohlson Model on mainland China stock market. Li Xing (2010) also concludes that the degrees of applicability of the three forms of linear information dynamic (LIM) and valuation function are different. More students applied the model to a specific industry. For example, Chen Xiaozhen (2011) estimated the Ohlson (1995) Model to power generation industry.

All the models mentioned above are still linear. Yet the relation between fundamental value and accounting figures cannot be as easy as linear (Burgstahler et al, 1997). One server drawback of Ohlson model and its variants is the model sometimes generates negative value. Yet, even if the earrings and book value are all negative, for shareholders, the company cannot be valued at a negative figure. Burgstahler (1997) named the value derived by Ohlson Model recursion value and developed the concept of adaption value, which is the real option value of a company to change operation. Fundamental value should be the summation of recursion value and adaption value (Burgstahler et al, 1997).

2.2 Research Model

In this paper, we use regression model proposed by Bukhvalov and Volkov (2005). This model is a modified version of a residual earnings model used in Ashbaugh and Olsson (2002). Generally, the model uses market value as dependent variable, book value of equity and discounted residual earnings as independent variables. The intuition behind this model is that it capitalizes residual earning by treating it as perpetuity.

Specifically, the model can have several variants as labeled from 1 to 4 below. The coefficients can be estimated on per share basis like Model 1 and Model 2 or on the whole company basis like Model 3 and Model 4. In addition, we can impose additional restriction on β_0 and command β_0=0 like Model 2 and Model 4, for a lack of economic sense of the intercept in the model (Bukhvalov, Akulaeva, 2014). Pooled panel regression is used in estimating these models. We want to get an overall understanding of how book value of equity and perpetuity value of residual earning affect fundamental value of equity. The estimated equation should be applicable to other companies and in future years. For these reasons, fixed effect and random effect, which lead to zero managerial implication, should not be applied in this context.

$$P_{i\,t} = \beta_0 + \beta_1 BPS_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t} \qquad \text{Model 1}$$

$$P_{i\,t} = \beta_1 BPS_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t} \qquad \text{Model 2}$$

$$Cap_{i\,t} = \beta_0 + \beta_1 E_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t} \qquad \text{Model 3}$$

$$Cap_{i\,t} = \beta_1 E_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t} \qquad \text{Model 4}$$

$$RI_{i\,t-1} = NI_{i\,t-1} - k_{i-1} E_{i\,t-2}$$

$$BPS_{i\,t-1} = \frac{E_{i\,t-1}}{S_{i\,t}}$$

P is stock price

BPS is book value per share

S is total number of shares outstanding

Cap is market capitalization of a specific company

E is total equity attributable to equity holders of the company from consolidated balance sheet

RI is residual income, which is also called residual earnings or abnormal earnings.

K is cost of capital as a discount rate

NI is net profit attributable to shareholders of the company from consolidated income statement

β_0, β_1, and β_2 are all coefficients from regression

To compare the quality of different models, this paper uses mean and median Absolute Percentage Error for sample test. Barth et al (2005) also used this indicator to compare different accounting based valuation models. Absolute percentage error is a more intuitional and straightforward measurement of the fitness of the model in valuation. Investors care more about gain and loss in percentage term. Casella (1983) points out that R squared from regression through origin is not comparable with the usual regression. Different statistic packages generate different R squared for zero intercept regression. Moreover, OLS regression result is more favorable to large capitalization company when the dependent variable is market capitalization.

$$\text{Absolute percentage error}_{i\,t} = \left|\frac{Cap_{i\,t} - V_{i\,t}}{Cap_{i\,t}}\right|$$

V_i is fundamental value of the company from forecast.

2.3 Discounting Rate

Discounting is key procedure in valuation. Different discount rate, cost of capital, should be applied to different items concerning their level of uncertainty. In this paper, cost of equity should be used as discount rate. Another important concept relating to cost of equity is equity risk premium. Equity risk premium is the return difference between investing in risk free assets and the whole equity market.

How to measure equity risk premium, a key component in valuation, is still under discussion. Historical return is the standard approach to estimate cost of equity. Even in US market with long historical data available, this method has certain limitations. In emerging markets, this method is not applicable because of volatile stock market performance and short history (Damodaran, 2015).

Generally, there are three approaches to calculate equity risk premium: historical return, survey, and implied equity risk premium. Damodaran discussed equity risk premium and estimation approaches in detail in his annual working paper. Nevertheless, every approach has its limitation.

Dechow, Patricia M., Amy P. Hutton, and Richard G. Sloan (1999) uses a constant rate for all the candidate models across companies, 12%, which is the long run approximate average realized return on US equity market. Ota, Koji (2002) utilizes CAPM and time varying beta to calculate cost of equity for every company. According to Penman et al (1998), “The cost of capital determination is elusive”. Thus they applied many alternatives: time varying risk free rate plus a constant risk premium cross companies, cost of equity from CAPM for each company, a constant rate for all companies over the period. Above all, there are several alternatives but no consistent solution for the discount rate.

In this paper, the discount rate is calculated as the sum a constant equity risk premium plus risk free rate. We use a constant equity risk premium calculated by Zhu, Jie (2008). The author concludes that the real equity risk premium for China mainland market is 11% and for Hong Kong is 10.3%. For risk free rate, three-month deposit rate is used as risk free rate for China and the three-month HIBOR (Hong Kong Interbank Offer Rate) is used as risk free rate for Hong Kong. Data is from DataStream. These two choices are consistent with the risk free rate used in the paper (Zhu and Jie, 2008) for calculating the equity risk premium.

This paper does not convert dependent variable and independent variable into US dollar term. In China market the currency is RMB and in Hong Kong the currency is HKD. Equity risk premium and risk free rate are all in their corresponding local perspective.

Chapter 3: Empirical Analysis

3.1 Data Collection

We estimate the above four models using mainland China company data from 2002 to 2016. Here the years refer to the year that share price is collected. To assess the quality of the model and compare them, we run in sample forecast and out of sample forecast. Out of sample forecast uses data from 1997 to 2001.

For China mainland market, we collected data from 1997 to 2016. Yet, for Hong Kong market we only have data from 2002 to 2016 due to data availability. We use the same period data of two markets to estimate the model and use the model for dual listed Chinese companies. Additional data for China mainland market is used for out of sample test.

The type of the data is unbalanced panel data. Each year is a cross section. Each cross-section has 2840 companies. All companies except financial institutions that went IPO on Shanghai Stock Exchange and Shenzhen Stock Exchange before 2015 December 31 are included. Data source is Eastmoney Choice. This is an unbalanced panel since many companies are not listed in the early years of the period investigated and some companies delisted from exchange later. Thus information of these companies in some cross sections is not available.

There are 22 cross sections, from year 1995 to year 2016, in this panel. Only 20 cross sections are used, because 2 years lagged data of book value of equity should be collected to calculate residual earnings and dependent variable is regressed on lagged equity and residual earnings. Book value of equity data is from 1995 to 2015. Income data and total asset are from 1996 to 2015. Price data and number of shares outstanding data are from 1997 to 2016.

For the data collected in this research, book value of equity and income are scaled in 100 million RMB or HKD. Number of shares is scaled in 100 million shares.

Book value of equity is from the consolidated balance sheet equity attributable to equity holders of the company account of company annual report. Income is from net profit attributable to shareholders of the company from consolidated income statement. Price, $P_{i\,t}$, is the average stock price based on transaction volume during the fourth week of April each year. Number of shares, $S_{i\,t}$, is the number of shares outstanding on 24 April each year. The reason behind such arrangement is that companies list in China mainland are required to reveal last year's annual report before April 30. This date is also the deadline for report the first quarter report every year. Ideally, we want to use stock price after the annual report disclosure and before the disclosure of the first quarter report so that the stock price contains information for the past year but not the first quarter. Yet in practice, this is not possible since every company is free to choose disclosure date before the deadline. Thus we use the compromise approach above.

There are some other variables in the regression whose data is not collected directly. Market capitalization is calculated by multiplying the price and the number of shares. Book value per share is book value of equity divided by the number of shares of the next year April 24. Residual income equals net income minus the product of discount rate, k, and lagged book value of equity.

To eliminate outliers, for each variable in the regression, we treat extreme top and bottom one percentile observations in the pooled panel as missing observations (e.g. Collins, Maydew, and Weiss, 1997; Fama and French, 1998; Barth et al, 2005). One observation means one specific company-year. We also want to exclude observations that are extreme small and large and have a sample in which individuals are similar. For this reason, we collect total asset as a control variable and exclude largest five percentile and smallest five percentile company-year. Similar treatment is also seen in Barth et al (2005).

For Hong Kong market, data is collected in same way but only from 2002 to 2016. Thus the models are compared based on in sample test only. All figures for Hong Kong market are in HKD. For company whose reporting currency is different from HKD, the value of book value of equity, net income, and total asset is converted to HKD using spot rate. Same way of eliminating outliers is applied for Hong Kong market data.

3.2 Mainland China Market Results

Below is the regression results from China mainland market. All models are estimated using 15 years observations from 2002 to 2016. Out of sample test uses observations from 1997 to 2001. Out of sample means that company-years that do not lie between 2002 to 2016. T-statistics is from White's heteroskedasticity-consistent standard errors & covariance. This paper primarily uses Eviews. Yet, many scholars use Stata. As discussed before, different statistic packages generate different R squared for zero interception regression. Thus we provide R squared (adj. R squared) from both statistic packages. The adj. R squared in the parenthesis is from Stata.

Table 3.1, Model Estimation (China Mainland Market)

Model 1: $P_{i\,t} = \beta_0 + \beta_1 BPS_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t}$					Absolute Percentage Error			
					in sample		out of sample	
Observation	β_0	β_1	β_2	Adj. R^2	Mean	Median	Mean	Median

Value	23996	7.73	2.07	1.24	0.30	0.57	0.40	0.33	0.26
T-statistics		69.97	67.68	45.68					

Model 2: $P_{i\,t} = \beta_1 BPS_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t}$					Absolute Percentage error			
					in sample		out of sample	
	Observation	β_1	β_2	Adj. R^2	Mean	Median	Mean	Median
Value	23996	3.66	0.90	0.16 (0.71)	0.53	0.42	0.40	0.37
T-statistics		192.62	31.09					

Model 3: $Cap_{i\,t} = \beta_0 + \beta_1 E_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$						Absolute Percentage Error			
						in sample		out of sample	
	Observation	β_0	β_1	β_2	Adj. R^2	Mean	Median	Mean	Median
Value	23996	25.41	2.21	0.61	0.61	0.57	0.48	0.76	0.50
T-statistics		44.13	60.13	10.86					

Model 4: $Cap_{i\,t} = \beta_1 E_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$							Absolute Percentage Error	
					in sample		out of sample	
	Observation	β_1	β_2	Adj. R^2	Mean	Median	Mean	Median
Value	23996	2.58	0.57	0.54 (0.71)	0.47	0.44	0.51	0.52
T-statistics		72.04	10.28					

not significant (#); significant at 5% (*); significant at 1% (**); significant at 0.1% (no label)

All the coefficients including the constant are significant at 0.1% significance level in all four models; t-statistics are very high for each coefficient. Thus the model is applicable on China mainland stock market.

Overall, it is not clear which model is the best. Absolute Percentage Error distributions and descriptive statistics of in sample and out of sample test are showed in Appendix 2, Absolute Percentage Error. First we carry out Welch F-test to test whether mean is equal between all six pairs of Absolute Percentage Error. Null hypotheses of equal mean are rejected at 0.01% significance level for all pairs. Thus we can just compare the mean. For in sample test, Model 4 has the lowest mean, while for out of sample test, Model 1 has the lowest mean. Absolute Percentage Error distributions of in sample test having long tails shows the existence of outliers, which affect mean. If we compare median for both in sample and out of sample test, Model 1 is the best model. To conclude, Model 1 is the best model for China mainland market.

Having selected Model 1 as the best fit for mainland China market, we can further estimate the Model 1 on industrial basis using data from 2002 to 2016 since we have a large sample. Results are presented below. The Industry classification method is Global Industry Classification Standard (GICS). The coefficients vary greatly from industry to industry. This feature is in line with the finding from US data processed by Barth et al (2005). Information technology and health care sector have high fundamental value perceived by Chinese investors while utilities sector has the lowest valuation. We will compare the coefficients and preference on industry level with Hong Kong market results in Table 3.4.

Table 3.2, Model 1 Estimation (China Mainland, Industry Level)

Model 1: $P_{i\,t} = \beta_0 + \beta_1 BPS_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t}$

GICS Industry Sector	Number of Observations	Constant	Beta1	Beta2
Energy	670	8.08	1.61	1.09
Materials	4488	7.75	1.73	1.03
Industrials	5503	7.52	2.08	1.23
Consumer Discretionary	4076	7.59	1.88	1.19
Consumer Staples	1698	8.26	2.14	1.40
Health Care	1721	9.95	2.43	1.94
Information Technology	3029	10.09	2.53	1.70
Telecommunication Services	19	18.06**	1.90#	2.15*
Utilities	1010	6.80	1.02	0.61
Real Estate	1710	7.21	0.93	4.67

not significant (#); significant at 5% (*); significant at 1% (**); significant at 0.1% (no label)

3.3 Result Analysis and Discussion

We can compare the result with Model 4 estimated by Bukhvalov and Nikulin (2016) with Russia data. Their sample consists of all listed companies on MICEX from 2003 to 2015 excluding financial institutions. Russian data yields $\beta_1 = 1.46$ and $\beta_2 = 0.3$. With mainland China data, both coefficients are notably larger than empirical results from Russian data, which means on average Chinese mainland market values of similar companies are higher than in Russian markets.

When market capitalization is dependent variable as for Model 3 and Model 4, adjusted R squared is remarkably higher than when stock price is dependent variable. Yet, judging from

Absolute Percentage Error of both in sample and out of sample test, models with market capitalization as dependent variable are even worse. This empirical result shows R squared is not a perfect indicator of fitness.

Figure 3.1 and 3.2 below can explain this phenomenon. Figure 1 is Absolute Percentage Error of in sample stock price estimation from Model 1 against stock price. The second model is Absolute Percentage Error of in sample market capitalization estimation from Model 4 against market capitalization.

Figure 3.1 Stock Price and Absolute Percentage Error from Model 1

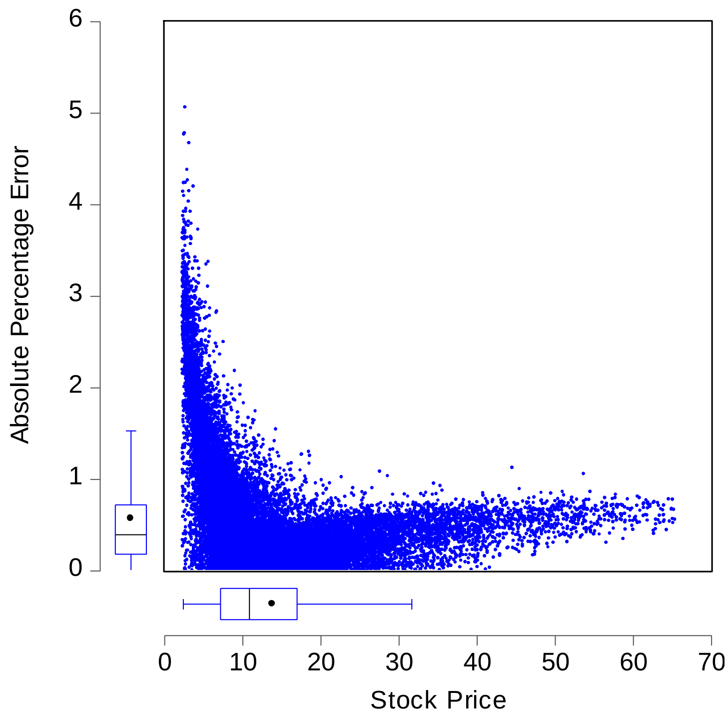
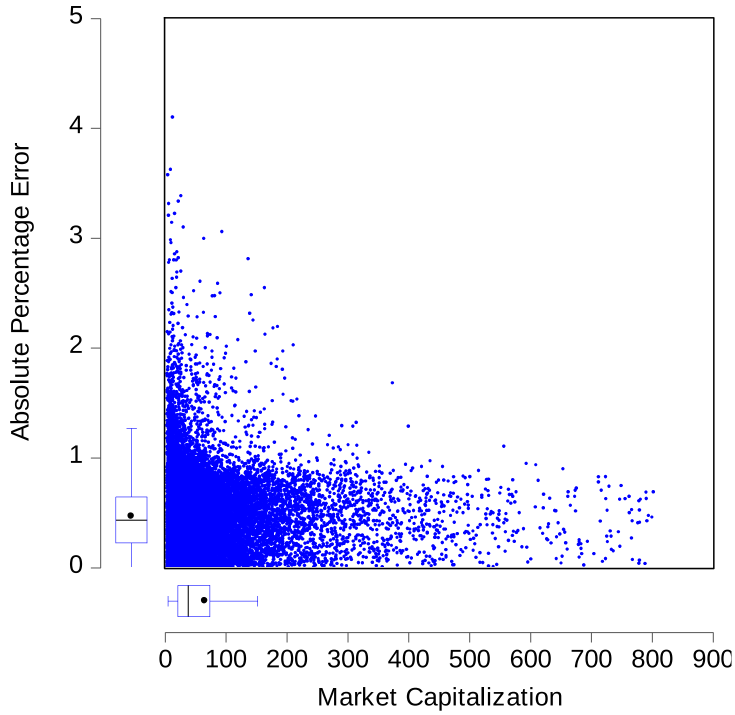


Figure 3.2 Market Capitalization and Absolute Percentage Error from Model 4



First of all, both graphs have distribution similar to inverse proportional function. OLS minimizes summation of squared error and estimates a regression line such that all the observations can evenly distributed around it. In other words, absolute error should be independent from the value of dependent variable such as stock price and market capitalization. Absolute percentage error equals absolute error divided by the real value of dependent variable. Thus when the dependent variable value is high, in percentage term, Absolute Percentage Error, is low.

Presence of right hand tail of the graph means there is a group of large observations fit in well with the estimated linear relationship. In Model 4, company with large capitalization fits the model better than small capitalization companies. The presence of this right hand tail increases R squared significantly. Take the second graph with market capitalization as dependent variable for example.

$$R^2 = \frac{SSR}{SST}$$

SSR: sum of square from regressing, $\sum(\mathrm{V_i} - \overline{\mathrm{Cap}})^2$

SST: sum of square total, $\sum(\mathrm{Cap_i} - \overline{\mathrm{Cap}})^2$

$\overline{\mathrm{Cap}}$: average capitalization of the sample

Value of $\overline{\text{Cap}}$ is the black point on the box plot on horizontal axis. For large companies, $(\text{Cap}_\text{i} - \overline{\text{Cap}})^2$ and $(\text{V}_\text{i} - \overline{\text{Cap}})^2$ are very large since capitalization of large company is a lot higher than the average and this difference between cap and average cap is squared. If a large number is squared, the outcome grows exponentially. For small companies, $(\text{Cap}_\text{i} - \overline{\text{Cap}})^2$ and $\sum(\text{V}_\text{i} - \overline{\text{Cap}})^2$ are all relatively small. Adding a large company in the sample is adding a similar but large number to the numerator and denominator of R squared, which makes R squared move towards 1.

We can define the right hand tail as the observations lies beyond the right whisker of the box plot. Market capitalization has a longer right hand tail than stock price as we compare the two figures. Because market capitalization has a longer right hand tail, its R squared is closer to 1.

We can also interpret the box plot on the vertical axis. For both Model 1 and Model 4, the majority of estimation is below Absolute Percentage Error of 1.5 since the upper inner fence of box plot is below 1.5.

3.4 Hong Kong Market Results

The four models are also tested with Hong Kong market data. All models are estimated using 15 years data from 2002 to 2016 data. No out of sample test is carried out. T-statistics is from White's heteroskedasticity-consistent standard errors & covariance. The data is collected in same way as mainland China market and result is presented below. The adj. Adj. R squared in the parenthesis is from Stata.

Table 3.3, Model Estimation (Hong Kong Market Level)

Model 1: $\text{P}_{\text{i t}} = \beta_0 + \beta_1 \text{BPS}_{\text{i t}-1} + \beta_2 \frac{\text{RI}_{\text{i t}-1}}{\text{k}_\text{t} * \text{S}_{\text{i t}}} + \varepsilon_{\text{i t}}$						Absolute Percentage Error in sample	
	Observation	β_0	β_1	β_2	Adj. R^2	Mean	Median
Value	12482	0.97	0.99	0.58	0.54	2.12	0.86
T-statistics		20.86	39.37	19.98			

Model 2: $\text{P}_{\text{i t}} = \beta_1 \text{BPS}_{\text{i t}-1} + \beta_2 \frac{\text{RI}_{\text{i t}-1}}{\text{k}_\text{t} * \text{S}_{\text{i t}}} + \varepsilon_{\text{i t}}$					Absolute Percentage Error in sample	
	Observation	β_1	β_2	Adj. R^2	Mean	Median
Value	12482	1.09	0.57	0.52 (0.64)	2.12	0.59
T-statistics		48.72	18.98			

Model 3: $\mathrm{Cap}_{i\,t} = \beta_0 + \beta_1 E_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$

						Absolute Percentage Error in sample	
	Observation	β_0	β_1	β_2	Adj. R^2	Mean	Median
Value	12482	14.07	1.21	0.61	0.65	2.90	1.26
T-statistics		10.54	37.68	8.17			

Model 4: $\mathrm{Cap}_{i\,t} = \beta_1 E_{i\,t-1} + \beta_2 \frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$

					Absolute Percentage Error in sample	
	Observation	β_1	β_2	Adj. R^2	Mean	Median
Value	12482	1.26	0.40	0.65 (0.70)	1.05	0.60
T-statistics		41.62	8.15			

not significant (#); significant at 5% (*); significant at 1% (**); significant at 0.1% (no label)

All the coefficients including the constant are significant at 0.1% significance level in all four models; t-statistics are very high for each coefficient. Thus the model is also applicable on Hong Kong stock market.

For Hong Kong Market, it is clear that Model 4 is the best model. We carry out Welch F-test to test whether mean is equal between all 6 pairs of Absolute Percentage Error. Null hypotheses of equal mean are rejected at 0.01% significance level for all pairs. Thus we can just compare the mean. For mean, Model 4 has the lowest value. For median Model 2 and Model 4 have almost same median. To conclude, Model 4 with market capitalization as dependent variable and without intercept is the best model. Overall, the fundamental valuation models that we analyzed in this paper have more accurate forecast in mainland China stock market than in Hong Kong.

Model 1 and Model 2 applied on Hong Kong market yields higher Absolute Percentage Error than in mainland China. Low stock price of Hong Kong listed company can be one of the reasons. In mainland China, stock price cannot be lower than 1 RMB, par value per share. Hong Kong does not have such regulation. It is common to see stock price lower than 1 HKD. Low stock price have a low denominator effect in Absolute Percentage Error calculation.

Russian data on Model 4 yields $\beta_1 = 1.46$ and $\beta_2 = 0.3$. With Hong Kong market data, value of both coefficients is not much different from empirical result from Russian data. Valuation on these two markets is similar.

Having selected Model 4 as the best fit for Hong Kong market, we can further estimate the model on industrial basis using Model 4 since we have a large sample. Results are presented below. The Industry classification method is Global Industry Classification Standard (GICS).

Table 3.4, Model Estimation (Hong Kong Industry Level)

Model 4: $\mathrm{Cap}_{i\,t} = \beta_1 \mathrm{E}_{i\,t-1} + \beta_2 \frac{\mathrm{RI}_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$

GICS Industry Sector	Number of Observations	Beta1	Beta2
Energy	594	1.32	0.58
Materials	1198	1.4	0.21**
Industrials	2187	1.226	0.16**
Consumer Discretionary	3535	1.51	0.81
Consumer Staples	683	2.12	1.33
Health Care	632	2.54	0.62
Information Technology	1355	1.85	0.72
Telecommunication Services	137	1.78	0.98**
Utilities	472	0.72	0.39**
Real Estate	1689	0.87	0.36

significant at 5% (*); significant at 1% (**); significant at 0.1% (no label)

Again on Hong Kong market, coefficients vary greatly among different industries. The highest valuation lies in consumer staples while real estate has the lowest valuation.

3.5 Pre-Listing Valuation in Hong Kong Market

There are various methods to list on Hong Kong Stock Exchange: Offer for Subscription, Offer for Sale, Placing, Introduction, and etc. Offer for Subscription means company issues new share to the public, which can be regarded as IPO (Initial Public Offering). Offer for Sale means existing shareholders sell their shares. Under Placing, the issuer or underwriter sells the share to the selected parties such as institutional investors instead of the public (HKEX, 2008). Company can choose one or a mixture of these methods to be listed. Small companies tend to choose Placing only to avoid large cost from an IPO. Thus IPO is not the only way to list on Hong Kong Stock Exchange. Large and medium IPOs usually combine the methods of Offer for Subscription and Placing.

The IPO pricing mechanism, Book Building, is applied in Placing. The issuer determines and discloses an indicative price range and promotes the company to institutional investors worldwide via road shows, etc. Through the purchase offers from institutional investors, the issuer finds the demand under different prices and determines the final offering price. (Morrison Foerster, 2012) This offering price is then used in placing share to institutional investors and Offer for Subscription to the general public. This paper uses this offer price in calculating company's market capitalization before listing.

The model we estimated can be utilized for evaluating company before listing on Hong Kong Stock Exchange. Fundamental value derived can be useful insight for the buyer side and the seller side. The demonstration can serve as guidance for applying the model.

First, one should collect all the inputs necessary:

1. book value of equity from prospectus or from the most recent annual report (E)
2. net income from the most recent 12 months available (NI)
3. book value of equity at the beginning of the period whose net income is collected (E*)
4. average 3 months Hong Kong Interbank Offer Rate during the period above (K)
5. present 3 months Hong Kong Interbank Offer Rate (K_0)

If the reporting currency is not HKD, convert the value into equivalent HKD.

Second, calculate residual earning (RI):

$$\mathrm{RI} = \mathrm{NI} - (\mathrm{K} + 0.103) * \mathrm{E}^*$$

Third, plunge in the value of E, RI, and k_0 to the equation below and get fundamental value estimation. The coefficients are from estimation of this paper (Model 4).

$$\text{Fundamental Value} = 1.26 * \mathrm{E} + 0.4 * \frac{\mathrm{RI}}{\mathrm{k}_0}$$

As shown in the table 5 Pre-listing Company Valuation below, we select 22 companies that listed on Hong Kong Stock Exchange in 2016 and applied the Model 4 estimated on the whole market level and GISC sector level. Comparing the fundamental value derived from the model and company valuation before listing via real offering price, one can see how the model performs in real situation.

Table 3.5, Pre-listing Company Valuation

Company Trading Code	*Listing Date*	*GICS Sector Name*	*Valuation Before Listing*	*Fundamental Value*	*Percentage Error*	*Fundamental Value (GICS Industry)*	*Percentage Error*
01496.HK	2016-04-08	Real Estate	535	185	-65.3%	135	-74.7%
02738.HK	2016-04-15	Materials	1,071	691	-35.5%	560	-47.7%
01585.HK	2016-05-19	Consumer Discretionary	3,922	2,575	-34.3%	4,242	8.2%
08187.HK	2016-05-30	Consumer Discretionary	180	40	-77.8%	65	-64.1%
02588.HK	2016-06-01	Industrials	24,776	27,233	9.9%	24,546	-0.9%
01420.HK	2016-06-08	Industrials	731	455	-37.8%	363	-50.4%
08280.HK	2016-06-27	Consumer Discretionary	884	453	-48.8%	1,066	20.6%
08102.HK	2016-06-30	Consumer Discretionary	213	54	-74.8%	69	-67.8%
01549.HK	2016-07-06	Industrials	331	209	-36.8%	136	-58.8%
08292.HK	2016-07-06	Industrials	210	101	-52.0%	80	-62.0%
08229.HK	2016-07-08	Information Technology	174	86	-50.4%	129	-26.1%
08281.HK	2016-07-08	Consumer Staples	323	249	-22.8%	553	71.6%
08232.HK	2016-07-11	Consumer Discretionary	176	50	-71.4%	55	-68.6%
08328.HK	2016-07-11	Consumer Discretionary	340	40	-88.4%	15	-95.7%
01586.HK	2016-07-12	Industrials	294	158	-46.3%	116	-60.7%
02869.HK	2016-07-12	Real Estate	3,980	966	-75.7%	827	-79.2%
08360.HK	2016-07-12	Industrials	230	75	-67.3%	43	-81.4%
01523.HK	2016-07-13	Information Technology	375	145	-61.3%	238	-36.5%
01560.HK	2016-07-13	Real Estate	302	278	-7.9%	212	-29.9%
01573.HK	2016-07-13	Energy	1,076	1,193	10.8%	1,485	37.9%
01579.HK	2016-07-13	Consumer Staples	2,551	738	-71.1%	2,105	-17.5%
03320.HK	2016-10-28	Health Care	41,109	30,758	-25.2%	60,884	48.1%
Mean Percentage Error					-46.8%		-33.4%
Mean Absolute Percentage Error					48.7%		50.4%

$Percentage\ error = \frac{Fundamental\quad value - Capitalization}{Capitalization}$; Valuation before listing = offer price*number of shares outstanding before listing; Valuation and fundamental value are in million HKD.

Several insights can be seen from the results above. Most importantly, the model can be applied for valuation of large company, such as company 02588.HK and 03320.HK. This finding is in line with the graphical analysis of Absolute Percentage Error for China mainland sample in Figure 1. Large market capitalization company has lower Absolute Percentage Error. Same phenomenon is observed in Russian data Bukhvalov and Nikulin (2016) where mean percentage error for top 15 large companies is smaller than for the whole sample. Moreover, according to mean percentage error, companies are undervalued using this valuation model. One possible explanation is that the model does not price in growth opportunity. Finally, comparing percentage error for market level model and GICS sector level, one can see estimating fundamental value from industry level is not superior at least in pre-listing situation.

For IPO of large companies, this method is accurate enough for the issuer to have an indicative price range before Book Building. The simplicity of this model is suitable for individual investors to judge the offer price and decided whether to make subscription for the new share. Valuation is necessary in multiple stages of an IPO. For institutional investors and brokers, this method can serve as a supplementary to their more sophisticated models.

Chapter 4: Fundamental Value and A/H Premium

4.1 A/H Premium with single factor

Since all four models are estimated with two markets data, we gather the results and compare them first.

Table 1.1, Fundamental Value Comparison

Mainland China	Hong Kong
$P_{i\,t} = 7.73 + 2.07BPS_{i\,t-1} + 1.24\frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t}$	$P_{i\,t} = 0.97 + 0.99BPS_{i\,t-1} + 0.58\frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t}$
$P_{i\,t} = 3.66BPS_{i\,t-1} + 0.9\frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t}$	$P_{i\,t} = 1.09BPS_{i\,t-1} + 0.57\frac{RI_{i\,t-1}}{k_t * S_{i\,t}} + \varepsilon_{i\,t}$
$Cap_{i\,t} = 25.41 + 2.21E_{i\,t-1} + 0.61\frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$	$Cap_{i\,t} = 14.07 + 1.21E_{i\,t-1} + 0.61\frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$
$Cap_{i\,t} = 2.58E_{i\,t-1} + 0.57\frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$	$Cap_{i\,t} = 1.26E_{i\,t-1} + 0.4\frac{RI_{i\,t-1}}{k_t} + \varepsilon_{i\,t}$

Clearly, for each model, coefficients and constants are much larger in mainland China than in Hong Kong. Fundamental value in the two markets is very different. If a company is traded both in mainland China and in Hong Kong, its fundamental value should be valued higher in mainland than in Hong Kong. Based on observation, the hypothesis below is formulated.

Hypothesis: Fundamental value discrepancy is a factor leading to stock price discrepancy of dual listed companies.

To conclude whether fundamental value discrepancy is a factor leading to stock price discrepancy, we formulate the hypothesis and construct regression analysis to test the hypothesis utilizing the dual listed company sample from 2002 to 2016.

There are mainly two ways to construct the dependent variable. The first way is to take division of A-share price and H-share price as used in Wang and Lin (2010) and Wu and Gao (2015). The concept of A-share and H-share is introduced in 1.2 Dual Listed Share Phenomenon. The second way is to take difference between A-share price and H-share price as used in Baozhi et al (2010); Wu and Li (2011). The first approach is more informative since the dependent variable is the A/H premium, which is in percentage term.

However, in the context of this research, the second approach is adopted. The reason is that we need to derive liner relationship between price discrepancy and fundamental value discrepancy using OLS. In case share price difference is depicted as a quotient, we should also take division for fundamental value. If discrepancy is expressed as quotient of two fundamental values, it yields not only outliers, because of low denominator effect, but also negative value, which is meaningless. We can see the distribution of A-share Fundamental Value/H-share Fundamental Value in Appendix 1 Variable Distributions. On the other hand, A-share Price/H-share Price is always positive. The quality of liner relationship is deteriorated if we use division for both variables. For this reason, discrepancy is modeled as difference in share price and the following model is constructed.

$$P_{i\,t} = \beta_0 + \beta_1 * F_{i\,t} + \varepsilon_{i\,t} \qquad \text{Equation (4.1)}$$

P is price difference measured by A-share price minus H-share price*HKDCNY

F is fundamental value difference measured by A-share fundamental value minus H-share fundamental value*HKDCNY

Equation (4.1) implies the model is simply a pooled regression. If every company in this sample is heterogeneous and we believe this heterogeneity affects price difference, fixed effects or random effects should be applied as Equation (4.2).

$$P_{i\,t} = \beta_0 + \beta_1 * F_{i\,t} + u_i + \varepsilon_{i\,t} \qquad \text{Equation (4.2)}$$

If u is correlated with F, the model is fixed effect, if u is not correlated with F, the model is random effect. Empirically, by running Hausman Test, whose null hypothesis is random effect, we choose between fixed and random effects. In addition, F Test is used to choose between pooled regression and fixed effects. Breusch-Pagan Lagrange Multiplier Test is used to choose between pooled regression and random effects.

We do hypothesis test by running the regression with sample of dual listed companies from 2002 to 2016. A-share fundamental value is calculated directly from Model 1, since Model 1 is the best model for mainland China market. For H-share, fundamental value for the whole company is calculated first using Model 4 because Model 4 is the best model for Hong Kong market. Fundamental value of H-share equals fundamental value of the whole company divided by number of shares outstanding. H-share price and H-share fundamental value are converted to RMB. Panel

Unit Root Test for both price difference and fundamental value difference are rejected, which means they are stationary.

Table 2.2, Price Difference Single Factor Model

Model	$P_{i\,t} = \beta_0 + \beta_1 * F_{i\,t} + \varepsilon_{i\,t}$ Pooled Regression			
	Observation	β_0	β_1	Adj. R^2
Value	676	2.19	0.19	0.0306
T-statistics		3.5016	2.9154	
P-value		0.0005	0.0037	
Breusch-Pagan LM test p-value is 0, supporting random effect				

Model	$P_{i\,t} = \beta_0 + \beta_1 * F_{i\,t} + \mathrm{u_i} + \varepsilon_{i\,t}$ Fixed Effect			
	Observation	β_0	β_1	Adj. R^2
Value	676	1.56	0.25	0.3994
T-statistics		3.4516	5.9279	
P-value		0.0006	0	
F test p-value is 0, supporting fixed effect				

Model	$P_{i\,t} = \beta_0 + \beta_1 * F_{i\,t} + \mathrm{u_i} + \varepsilon_{i\,t}$ Random Effect			
	Observation	β_0	β_1	Adj. R^2
Value	676	1.81	0.24	0.0491
T-statistics		3.3057	5.9945	
P-value		0.0010	0	
Hausman test p-value is 0.4135, supporting random effect				

Pooled regression, fixed effects, and random effects are analyzed. Based on result from Breusch-Pagan LM Test, F Test, and Hausman Test, random effects should be adopted. The fundamental value difference variable is significant in random effects model. Nevertheless, in all three occasions, this coefficient is significant. The sign of this coefficient is positive. This was expected. If A-share fundamental value is higher, A-share price should be higher than its H-share counterpart.

In conclusion, fundamental value discrepancy is a factor leading to stock price discrepancy for dual listed companies on China mainland stock market and Hong Kong Stock Exchange.

4.2 A/H Premium and multi-factors regression

Random effects and low R^2 imply that there are other factors that are not accounted in the model with only fundamental value difference. As mentioned in the first chapter, many researches already identified other factors that are significant in explaining A/H premium or price difference. We did a brief literature review as shown in the table 4.3 and added more independent variables in the previous regression model. We expect this can increase R^2 in the regression. Also, this means closing the research gap by adding fundamental value difference to previous research on A-share and H-share discrepancy.

Table 3.3, Literature Reviews for Other Factors

Factor	Variable	Paper
Liquidity	Turnover	Wu and Gao (2015), Wang and Lin (2010)
Asymmetric Information	Market Capitalization	Wu and Gao (2015), Qu et al (2010)
Demand Elasticity	Percentage of outstanding shares	Wang and Lin (2010)
	Number of shares	Wu and Gao (2015), Wang and Lin (2010)
Risk Preference	Variance of Return	Wu and Gao (2015)
	Beta	Wang and Lin (2010)

Considering previous literature, more independent variables are added. For asymmetric information hypothesis, it is argued that mainland China investors have informational advantage especially for small Chinese companies, which are not well-known for Hong Kong investors (Wu and Gao, 2015; Qu et al, 2010). Thus Hong Kong investors are not willing to invest in the company they are not familiar with. To represent the scale of a company, total asset is used instead of market capitalization in this paper because using any dependent variables to calculate an independent variable in regression equation is not preferable. The expected coefficient sign of total asset is negative. Since asymmetric hypothesis, the larger the company is, the higher the H-share price is.

Table 4.4 Additional Variables

Identifier	Variable	Definition
T	Turnover	Number of shares traded from February to April divided by total number of A-share or H-share
V	Volatility	Standard deviation of daily return

TA	Total Asset	Total asset at the end of the year

$$\mathrm{P} = \beta_0 + \beta_1 * \mathrm{F} + \beta_2(\mathrm{T_A} - \mathrm{T_H}) + \beta_3(\mathrm{V_A} - \mathrm{V_H}) + \beta_4 \log(TA) + \varepsilon_{i\,t} \qquad \text{Equation (4.3)}$$

$\mathrm{T_A} - \mathrm{T_H}$: A-share turnover minus H-share turnover

$\mathrm{V_A} - \mathrm{V_H}$: A-share volatility minus H-share volatility

$\log(TA)$: natural logarithm of total asset of the company

Adding three more regressors, we construct the model as Equation (4.4). This equation is a pooled panel. We test the fixed effects version and random effects version of this pooled panel in the same way as one regressor as shown in Equation (4.2). Natural logarithm of total asset decreases heteroskedasticity and removes unit root. All the three additional variables are rejected by Panel Unit Root Test. Distribution of these three variables is in Appendix 3.

Table 5.5, Price Difference Multiple Factors Model

Model:	Pooled Panel			
Adj. R^2	0.2080			
Variable	Coefficient	Value	T statistic	P-value
Constant	β_0	3.9930	5.8212	0.0000
F	β_1	0.2604	6.9361	0.0000
$\mathrm{T_A} - \mathrm{T_H}$	β_2	0.0111	7.0330	0.0000
$\mathrm{V_A} - \mathrm{V_H}$	β_3	-0.2251	-1.3822	0.1675
$\log(TA)$	β_4	-0.6053	-6.2018	0.0000
Breusch-Pagan LM Test p-value is 0, supporting random effect				

Model:	Fixed Effect			
Adj. R^2	0.5360			
Variable	Coefficient	Value	T statistic	P-value
Constant	β_0	2.5176	1.5609	0.1192
F	β_1	0.2499	5.9675	0.0000
$\mathrm{T_A} - \mathrm{T_H}$	β_2	0.0090	6.0420	0.0000
$\mathrm{V_A} - \mathrm{V_H}$	β_3	-0.1510	-1.0429	0.2975
$\log(TA)$	β_4	-0.3016	-1.0893	0.2765

F Test p-value is 0, supporting fixed effect

Model:	Random Effect			
Adj. R^2	0.1601			
Variable	Coefficient	Value	T statistic	P-value
Constant	β_0	4.6576	4.4891	0.0000
F	β_1	0.2664	6.9171	0.0000
$\mathrm{T_A} - \mathrm{T_H}$	β_2	0.0094	6.6937	0.0000
$\mathrm{V_A} - \mathrm{V_H}$	β_3	-0.1905	-1.3482	0.1781
$\log(TA)$	β_4	-0.6879	-4.3296	0.0000
Hausman Test p-value is 0.1857, supporting random effect				

After introducing more independent variables, pooled panel, fixed effect, and random effect are analyzed. Based on result from Breusch-Pagan LM Test, F Test and Hausman Test, still random effect should be adopted. Fundamental value difference is still significant, which supports the previous conclusion.

For the three additional variables other than fundamental value difference, turnover difference and total asset are significant while volatility difference does not show significance. For fundamental value difference, this variable is significant still after adding additional variables.

For the variable measuring risk, Wu and Gao (2015) used variance of return to test the risk preference and resulted in a p-value of 0.0526 from fixed effect model. Wang and Lin (2010) used betas of the two markets without taking difference and concluded that both betas are significant on 0.1% significance level. However, the risk measurement we used is not significant in pooled panel, fixed effects, and random effects.

Conclusions

This paper tests a fundamental valuation model using book value of equity and discounted residual earnings as input. This model has been tested on Russian market and US market. This paper expanded the usage of this model by confirming its significance on China stock market and estimates the coefficients. The model is estimated separately on mainland China market and Hong Kong market with 15 years data since China mainland and Hong Kong Special Administrative Region have totally different economic conditions. Estimation results on whole market level and GICS industry level are presented in Chapter 3.

Four variants of this model, named as Model 1 to Model 4 are compared. Model 1 and Model 2 use per share data: stock price, equity per share, and residual earnings per share. Model 3 and Model 4 use market capitalization, book value of equity, and residual earnings. Model 2 and Model 4 use regression with zero intercept. For China mainland, Model 1 is the best and for Hong Kong Model 4 is the best. For valuation purpose, this paper chooses the best variants to derive company fundamental value on each market. Yet, why certain model variant is better than the other is largely unexplained. This can be a direction for follow on research.

Moreover, this paper explains the market price difference of dual listed Chinese companies on mainland China market and Hong Kong Stock Exchange with fundamental value difference. Regression using fundamental value difference as independent variable is constructed for hypothesis test. Fundamental value difference is significant in all model specifications. To conclude, fundamental value discrepancy is a factor leading to market price discrepancy. This finding closes gap of research on A-share and H-share premium.

For managerial implications, as a valuation technique, it can be applied to various contexts of equity valuation, for example IPO valuation as demonstrated in this paper. If the model is estimated on several markets, company can also compare the valuation of these markets and choose to list on a market where the valuation is the highest.

The valuation model estimated in this paper is a supplementary to DCF and comparables valuation. Every method has advantages and disadvantages. In practice, various methods are used together to have a range of valuation. This model can be applied to quickly evaluate a large number of companies with a few input parameters as showed in calculating fundamental value of dual listed Chinese companies. For valuation of large companies, this model has accurate results.

This model also has its limitations. Firstly, this model yields negative value while market value for a listed company is always positive. To tackle this drawback, this paper chooses to depict fundamental value discrepancy as fundamental value difference instead of premium. Secondly, this model ignores growth expectation. In the original Ohlson (1995) Model, there is an independent variable defined as information about future abnormal earnings that is not in current abnormal earnings. Yet, this is unintelligible and difficult to quantify. This model drops this variable and does not price in the value of future growth. This may be the reason of companies consistently devalued by the model in pre-listing valuation.

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Appendix

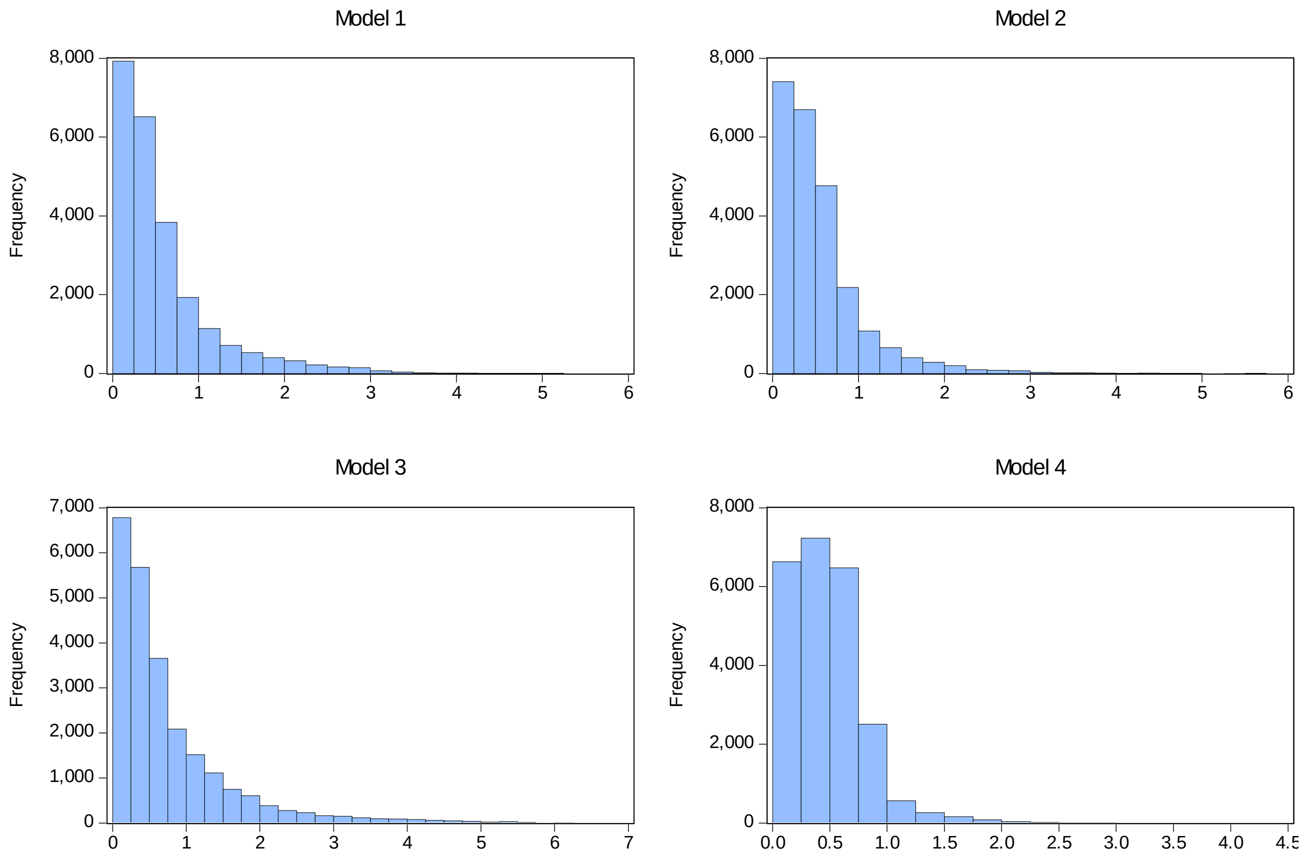
Appendix 1 Dual Listed Company A/H Premium

Dual Listed Company A/H Premuim (April 21, 2017)

Company Name	A/H Premuim	Code in HK	HK Price (HDK	Code in CN	CN Price (RMB)
Shandong Molong Petroleum Machinery Co.,Ltd	78.0%	00568.HK	1.39	002490	5.63
Luoyang Glass Company Limited	77.7%	01108.HK	5.21	600876	20.82
Zhejiang Shibao Company Limited	74.8%	01057.HK	7.47	002703	26.43
Northeast Electric Development Company Limited	69.2%	00042.HK	2.24	000585	6.47
Xinhua Winshare Publishing and Media Co., Ltd.	67.6%	00811.HK	6.91	601811	19.01
Shenji Group Kunming Machine Tool Company Limited	67.0%	00300.HK	2.49	600806	6.71
BEIJING JINGCHENG MACHINERY ELECTRIC COMPANY LIMITED	66.5%	00187.HK	3.13	600860	8.31
Tianjin Capital Environmental Protection Group Company Limited	64.4%	01065.HK	4.81	600874	12.01
Sinopec Oilfield Service Corporation	63.7%	01033.HK	1.47	600871	3.6
First Tractor Company Limited	62.9%	00038.HK	4.28	601038	10.26
COSCO SHIPPING Development Co.,Ltd.	62.7%	02866.HK	1.67	601866	3.99
Nanjing Panda Electronics Company Limited	61.6%	00553.HK	6.19	600775	14.36
Anhui Expressway Company Limited	61.2%	00995.HK	6.14	600012	14.09
CSSC Offshore & Marine Engineering (Group) Company Limited	60.8%	00317.HK	15.84	600685	35.97
Dalian Port (PDA) Company Limited	59.8%	02880.HK	1.4	601880	3.1
GUANGZHOU AUTOMOBILE GROUP CO.,LTD	57.6%	02238.HK	12.02	601238	25.23
Datang International Power Generation Co., Ltd.	56.2%	00991.HK	2.29	601991	4.65
Shandong Xinhua Pharmaceutical Company Limited	55.7%	00719.HK	7.11	000756	14.29
China Molybdenum Co., Ltd.	51.0%	03993.HK	2.47	603993	4.49
Zhengzhou Coal Mining Machinery Group Company Limited	50.9%	00564.HK	4.3	601717	7.79
Beijing North Star Company Limited	50.4%	00588.HK	3.01	601588	5.4
Metallurgical Corporation Of China Ltd.	50.1%	01618.HK	3	601618	5.35
China Communications Construction Company Limited	48.6%	01800.HK	10.96	601800	18.97
Yanzhou Coal Mining Company Limited	47.9%	01171.HK	6.86	600188	11.72
COSCO SHIPPING Holdings Co.,Ltd.	47.6%	01919.HK	3.31	601919	5.62
BBMG Corporation	47.5%	02009.HK	4.11	601992	6.97
China Oilfield Services Limited	45.8%	02883.HK	7.2	601808	11.83
China Eastern Airlines Corporation Limited	45.2%	00670.HK	4.29	600115	6.97
COSCO SHIPPING Energy Transportation Co., Ltd.	45.1%	01138.HK	4.26	600026	6.9
Huadian Power International Corporation Limited	44.8%	01071.HK	3.21	600027	5.18
China Southern Airlines Company Limited	42.6%	01055.HK	5.25	600029	8.14
Sichuan Expressway Company Limited	41.2%	00107.HK	3.38	601107	5.12
Dongjiang Environmental Company Limited	40.1%	00895.HK	12.88	002672	19.14
Sinopec Shanghai Petrochemical Company Limited	39.9%	00338.HK	4.39	600688	6.5
Huaneng Power International,Inc.	39.8%	00902.HK	5.2	600011	7.69
China Coal Energy Company Limited	39.7%	01898.HK	3.9	601898	5.76
Great Wall Motor Company Limited	38.6%	02333.HK	9.2	601633	13.34
Dongfang Electric Corporation Limited	38.3%	01072.HK	6.93	600875	9.99
Xinjiang Goldwind Science And Technology Co.,Ltd.	37.9%	02208.HK	11.14	002202	15.97
Air China Limited	37.4%	00753.HK	6.6	601111	9.39
PetroChina Company Limited	36.9%	00857.HK	5.52	601857	7.79
CRRC Corporation Limited	36.5%	01766.HK	7.54	601766	10.56
China Railway Group Limited	35.8%	00390.HK	6.7	601390	9.29
Hisense Kelon Electrical Holdings Co.,Ltd	34.7%	00921.HK	11.54	000921	15.73
Jiangxi Copper Company Limited	33.8%	00358.HK	12.1	600362	16.27
China Railway Construction Corporation Limited	31.1%	01186.HK	10.98	601186	14.19
Shandong Chenming Paper Holdings Limited	31.0%	01812.HK	9.78	000488	12.61
Livzon Pharmaceutical Group Inc.	30.0%	01513.HK	47.6	000513	60.5
China International Marine Containers (Group) Co.,Ltd.	28.8%	02039.HK	13.28	000039	16.59
Guangzhou Baiyunshan Pharmaceutical Holdings Company Limited	28.6%	00874.HK	23.4	600332	29.17
Shanghai Pharmaceuticals Holding Co.,Ltd	28.2%	02607.HK	19.74	601607	24.46
Maanshan Iron & Steel Company Limited	27.6%	00323.HK	2.66	600808	3.27
Shenzhen Expressway Company Limited	26.5%	00548.HK	7.08	600548	8.57
Zijin Mining Group Company Limited	25.7%	02899.HK	2.87	601899	3.44
ALUMINUM CORPORATION OF CHINA LIMITED	25.4%	02600.HK	4.05	601600	4.83
Zoomlion Heavy Industry Science And Technology Co., Ltd.	25.0%	01157.HK	3.85	000157	4.57
BYD Company Limited	21.9%	01211.HK	45.6	002594	51.97
Guangshen Railway Company Limited	18.7%	00525.HK	4.74	601333	5.19
China Shenhua Energy Company Limited	17.3%	01088.HK	17.8	601088	19.16
Shanghai Fosun Pharmaceutical (Group) Co.,Ltd.	14.6%	02196.HK	29.5	600196	30.74
China Vanke Co.,Ltd.	11.6%	02202.HK	20.55	000002	20.68
Angang Steel Company Limited	10.7%	00347.HK	5.26	000898	5.24
Tsingtao Brewery Company Limited	7.1%	00168.HK	35	600600	33.54
China Petroleum And Chemical Corporation	3.8%	00386.HK	6.27	600028	5.8
Weichai Power Co., Ltd.	0.1%	02338.HK	12.92	000338	11.51
Jiangsu Expressway Company Limited	-1.5%	00177.HK	11	600377	9.65
Fuyao Glass Industry Group Co., Ltd.	-6.9%	03606.HK	27.35	600660	22.78
Anhui Conch Cement Company Limited.	-12.4%	00914.HK	27.5	600585	21.78
ZTE Corporation	----	00763.HK	14.92	000063	----
Chongqing Iron & Steel Company Limited	----	01053.HK	1.5	601005	----
Shanghai Electric Group Company Limited	----	02727.HK	3.79	601727	----

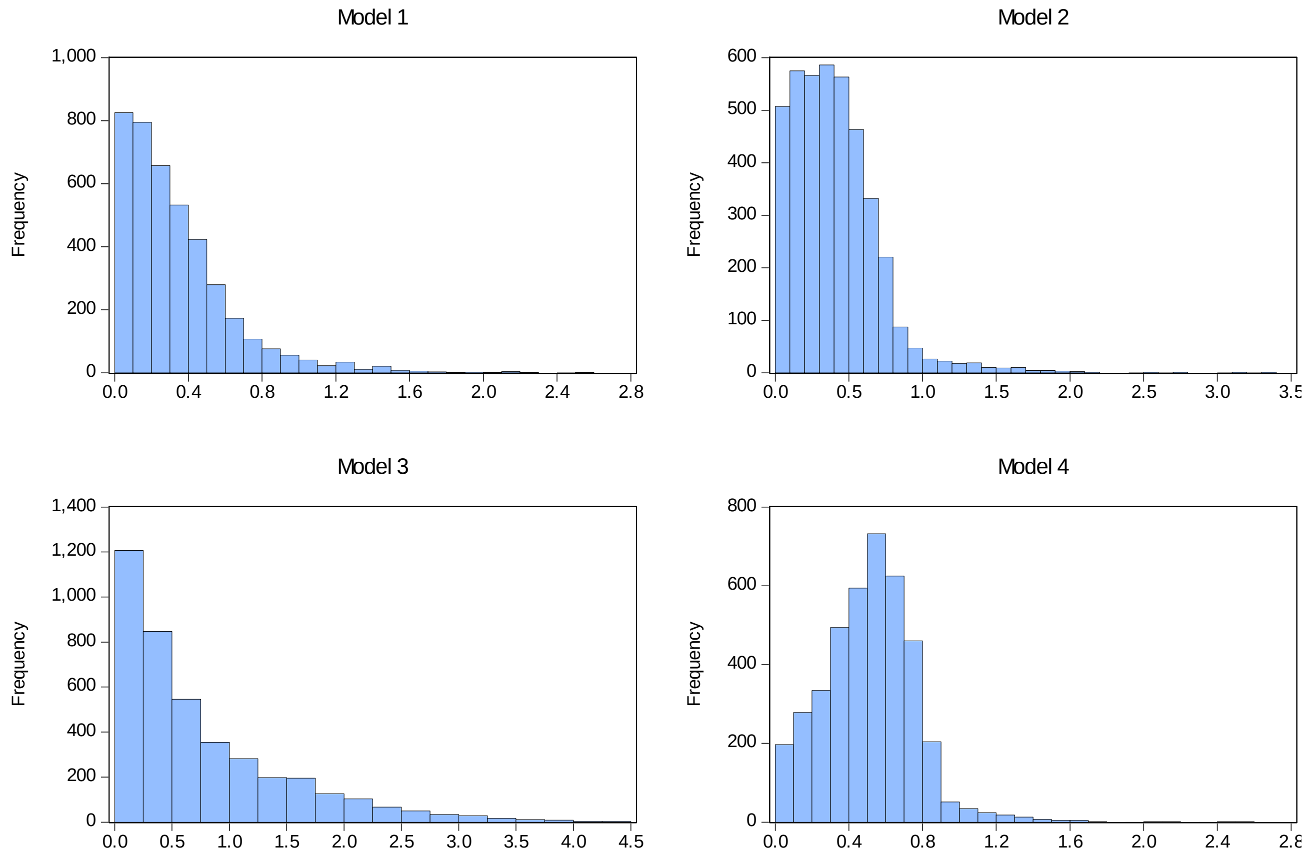
Appendix 2 Absolute Percentage Error

Mainland China (In Sample Test)



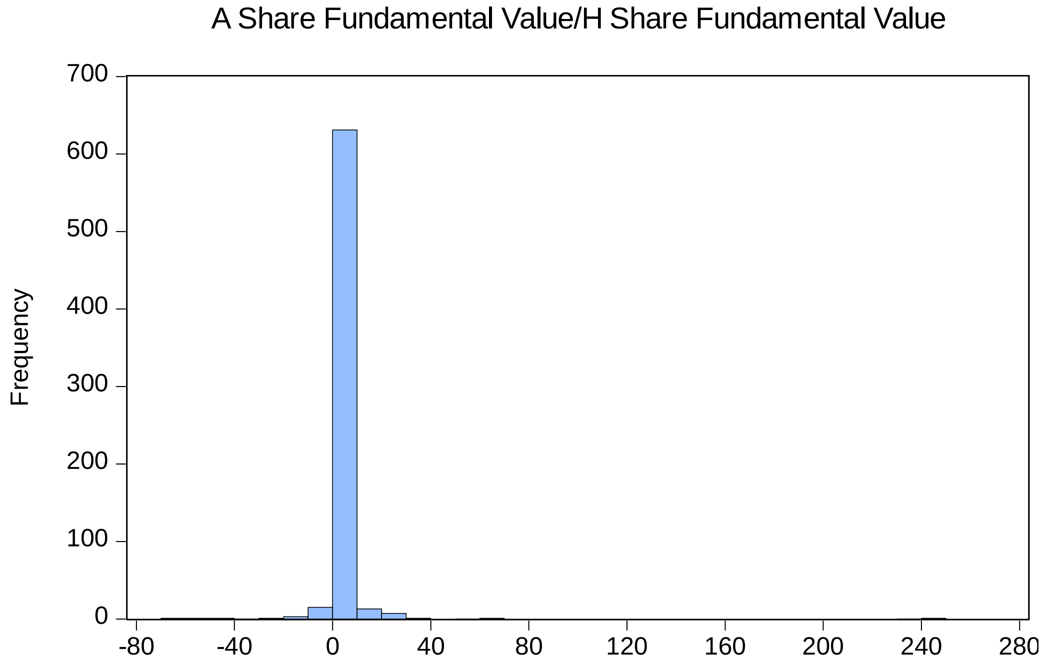
	Model 1	Model 2	Model 3	Model 4
Mean	0.5750	0.5351	0.7525	0.4689
Median	0.3952	0.4160	0.4757	0.4361
Maximum	5.0565	5.6820	6.7257	4.0947
Std. Dev.	0.5908	0.5013	0.8361	0.3295
Skewness	2.1204	2.3791	2.4103	1.6976
Kurtosis	8.4476	12.0466	10.3645	10.2942
Jarque-Bera	47651.7	104465	77461.9	64720.9
Probability	0.0000	0.0000	0.0000	0.0000
Number of Observations	23996	23996	23996	23996

Mainland China (Out of Sample Test)

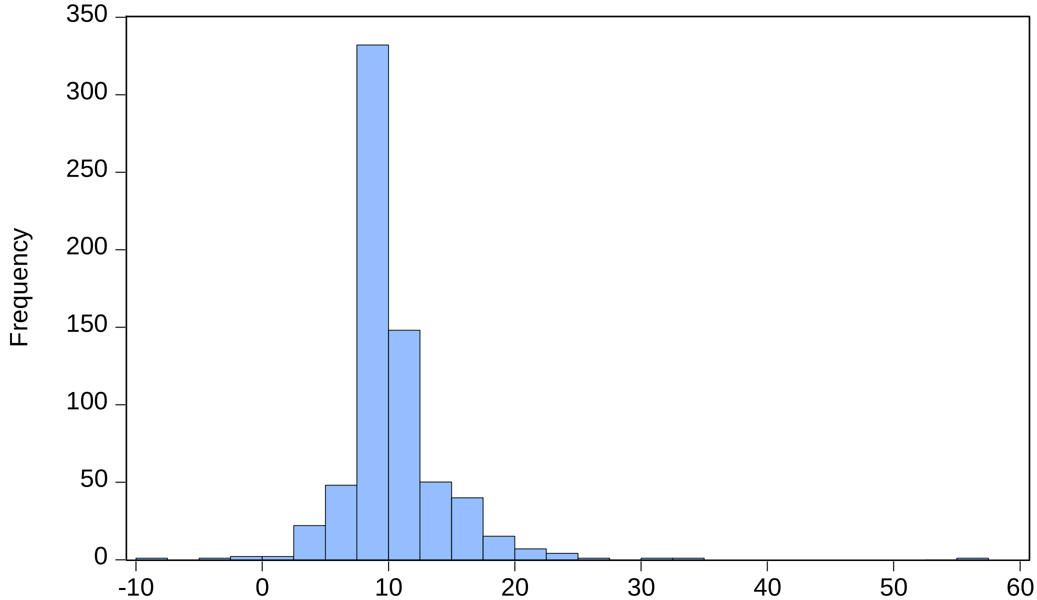


	Model 1	Model 2	Model 3	Model 4
Mean	0.3338	0.4028	0.7567	0.5123
Median	0.2627	0.3651	0.4955	0.5185
Maximum	2.5746	3.3019	4.3368	2.5280
Std. Dev.	0.2961	0.2945	0.7455	0.2501
Skewness	1.9081	1.8912	1.5430	0.7191
Kurtosis	8.6082	11.6724	5.3313	6.3807
Jarque-Bera	7818.6	15210.4	2541.6	2293.5
Probability	0	0	0	0
Number of Observations	4078	4078	4078	4078

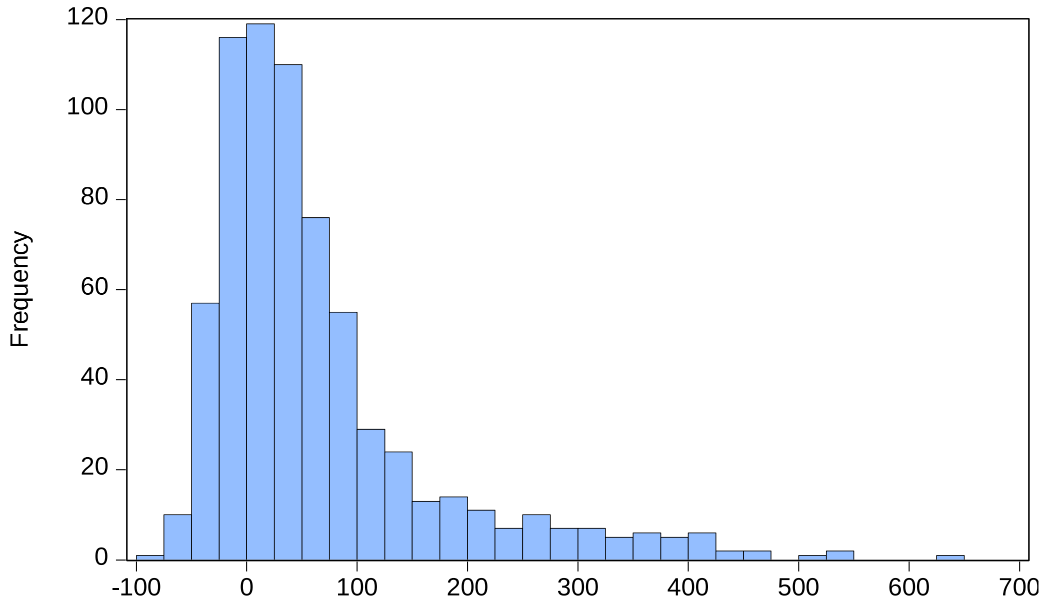
Appendix 3 Variable Distributions



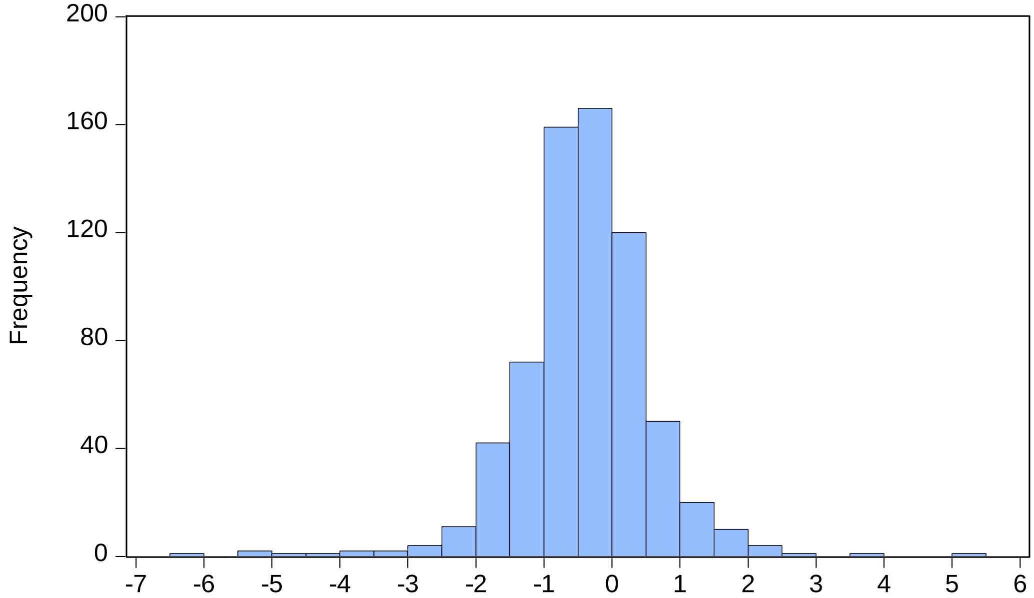
A Share Fundamental Value-H Share Fundamental Value



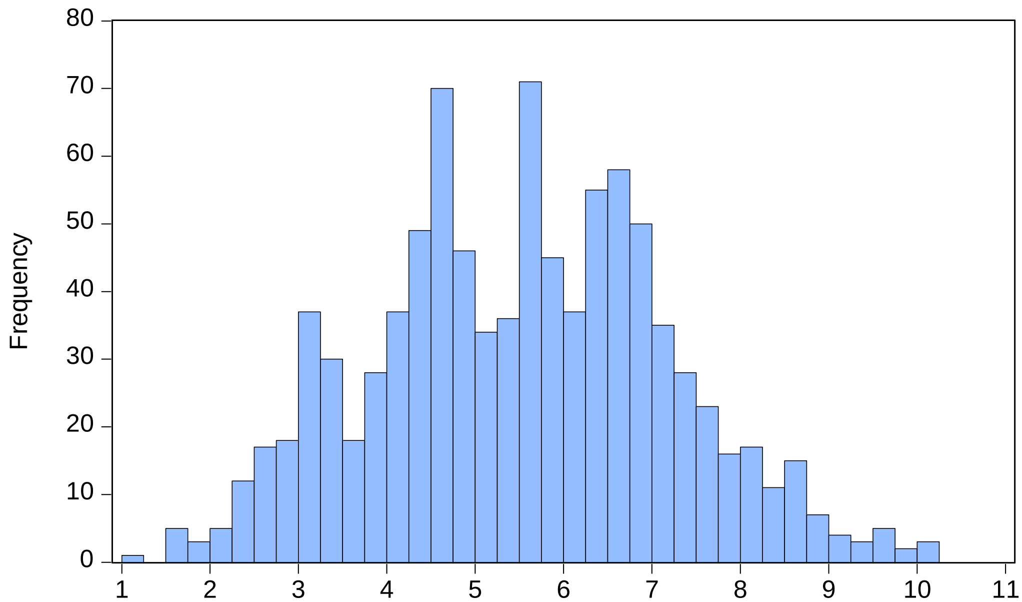
T_A - T_H (Turnover Difference)



V_A - V_H (Volatility Difference)



log(TA)



Appendix 4 Correlations between Variables

	P (Price Difference)	F (Fundamental Value Difference)	$T_A - T_H$	$V_A - V_H$	$\log(TA)$
P	1				
F	0.1999	1			
$T_A - T_H$	0.3231	-0.0378	1		
$V_A - V_H$	0.0028	0.0296	0.2235	1	
$\log(TA)$	-0.2710	0.1999	-0.2732	0.0589	1